KEYS TO THE BLACK FLIES (SIMULIIDAE) OF THE SASKATCHEWAN RIVER IN SASKATCHEWAN[1]

F.J.H. Fredeen
Canada Agriculture Research Station
107 Science Crescent
Saskatoon, Saskatchewan, Canada
S7N 0X2

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ABSTRACT

Illustrated keys to the larvae, pupae and adults of 15 species of black flies known to occur in the North, South and Main Saskatchewan Rivers in Saskatchewan are presented. Keys are based mainly upon external characteristics. Life histories, trends in abundance and economic importance are discussed. Species treated include Ectemnia taeniatifrons *(Enderlein),* Metacnephia saskatchewana *Shewell and Fredeen,* Simulium euryadminiculum *Davies,* S. duplex *Shewell and Fredeen,* S. meridionale *Riley,* S. rugglesi *Nicholson and Mickel,* S. bivittatum *Malloch,* S. griseum *Coquillett,* S. vittatum *Zetterstedt,* S. arcticum *Malloch,* S. luggeri *Nicholson and Mickel,* S. decorum *Walker,* S. tuberosum *(Lundstroem),* S. venustum *Say, and* S. verecundum *Stone and Jamnback.*

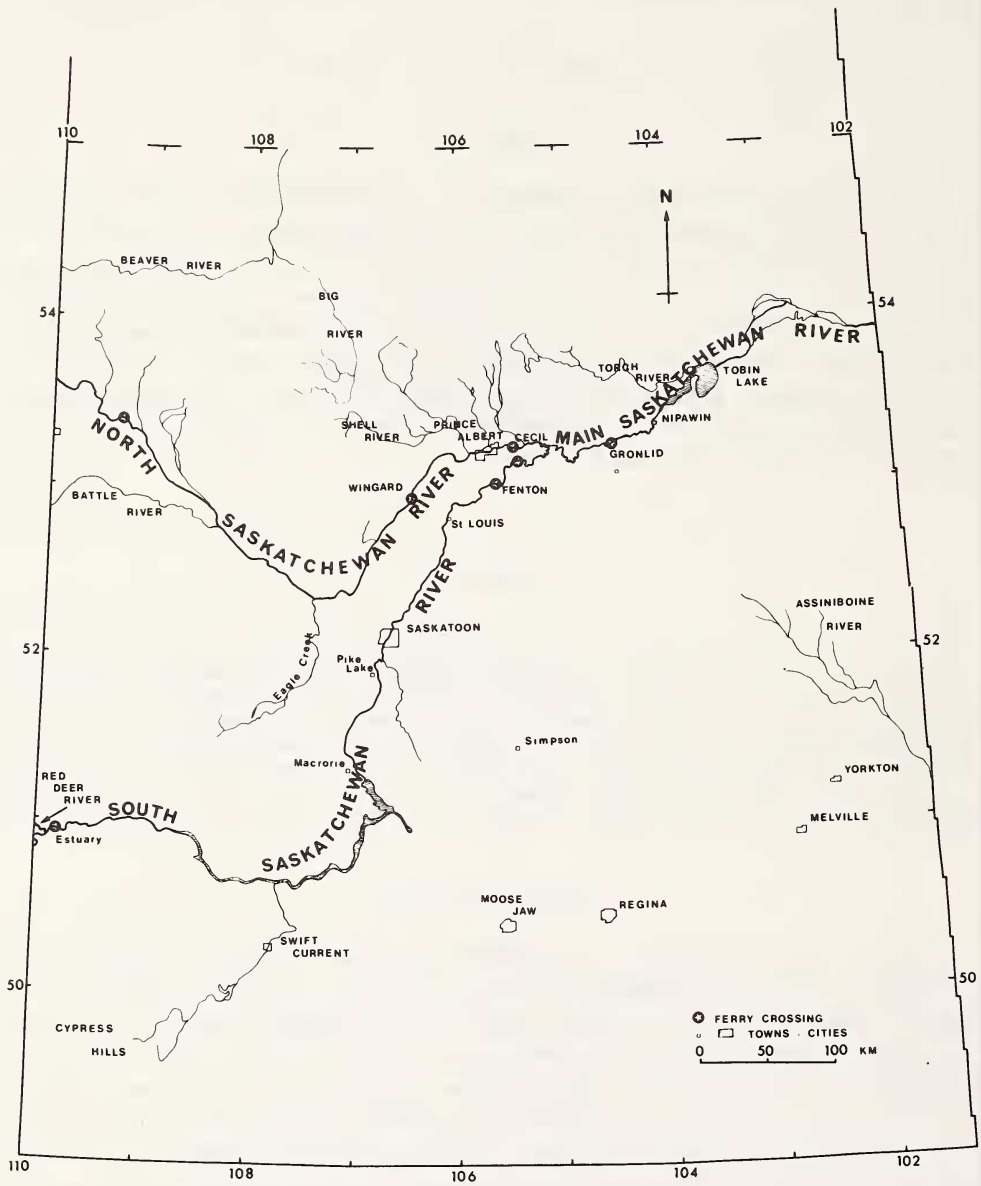
RÉSUMÉ

Clefs illustrées pour les larves, les pupaes, et les adultes de chacune des quinze espèces des mouches noires connues d'exister dans les trois Rivières de la Saskatchewan: la Nord, la Sud, et la Principale, sont presentées. Les clefs se basent principalement sur des charateristiques externelles. Des histoires naturelles, des tendanes d'abondance et de la signification économique sont discutées. Les especes sont Ectemnia taeniatifrons *(Enderlein),* Metacnephia saskatchewana *Shewell et Fredeen,* Simulium euryadminiculum *Davies,* S. duplex *Shewell et Fredeen,* S. meridionale *Riley,* S. rugglesi *Nicholson et Mickel,* S. bivittatum *Malloch,* S. griseum *Coquillett,* S. vittatum *Zetterstedt,* S. arcticum *Malloch,* S. luggeri *Nicholson et Mickel,* S. decorum *Walker,* S. tuberosum *(Lundstroem),* S. venustum *Say, et* S. verecundum *Stone et Jamnback.*

INTRODUCTION

For some 30 years the Agriculture Canada Research Station at Saskatoon has been involved in research on black flies inhabiting the Saskatchewan River (Map 1), particularly those species breeding in numbers sufficient to create economic problems. The river has changed considerably during this period, partly because of construction of hydropower dams and has trended toward relatively shallow, weedy conditions. Parallel with these changes, numbers of black fly species have increased, and dominance has shifted from *Simulium arcticum* Malloch to *Simulium luggeri* Nicholson and Mickel. This shift created new problems for residents in a large area of Saskatchewan because *Simulium luggeri* females attack humans as well as other animals and remain abundant all summer unlike *Simulium arcticum.* Direction of future changes will depend upon climatic conditions and upon artificial manipulations of the river, but

[1]Contribution No. 803, of the Research Station, Saskatoon



Map 1. The North, South, and main Saskatchewan Rivers, in Saskatchewan.

because of its large size the Saskatchewan River has potential for creating large black fly outbreaks. Thus, surveillance, research and abatement may be required for many more years.

These keys to larvae, pupae, and adults of the 15 species known to inhabit the river were prepared to aid future studies. External features are emphasized to facilitate sorting large samples. Taxonomic concepts and nomenclature of structures follow those used by Davies *et al.* (1962), Wood *et al.* (1963), Stone *et al.* (1965), Davies (1968), Stone and Snoddy (1969) and McAlpine *et al.* (1981). The keys are based upon specimens stored at the Agriculture Canada Research Station, Saskatoon, augmented by published descriptiions.

CHECKLIST OF SPECIES OF SIMULIIDAE FROM THE SASKATCHEWAN RIVER SYSTEM, SASKATCHEWAN, CANADA.

1. *Ectemnia taeniatifrons* (Enderlein)
2. *Metacnephia saskatchewana* Shewell and Fredeen
3. *Simulium (Eusimulium) euryadminiculum* Davies
4. *Simulium (Eusimulium) duplex* Shewell and Fredeen
5. *Simulium (Byssodon) meridionale* Riley
6. *Simulium (Byssodon) rugglesi* Nicholson and Mickel
7. *Simulium (Psilopelmia) bivittatum* Malloch
8. *Simulium (Psilopelmia) griseum* Coquillett
9. *Simulium (Psilozia) vittatum* Zetterstedt
10. *Simulium (Gnus) arcticum* Malloch
11. *Simulium (Phosterodoros) luggeri* Nicholson and Mickel
12. *Simulium (sensu stricto) decorum* Walker
13. *Simulium (sensu stricto) tuberosum* (Lundstroem)
14. *Simulium (sensu stricto) venustum* Say
15. *Simulium (sensu stricto) verecundum* Stone and Jamnback

KEYS TO GENERA AND SPECIES

ADULTS, Males

1 Entire vein R of wing clothed with hairs (setae) dorsally (Fig. 1) 2

1′ Basal section of vein R (Rb, Fig. 1) bare 5

2 (1) Ratio of length of basal section of radius (Rb, Fig. 1) to length of remainder of wing 1:2.5–1:3.0; basal cell present (Fig. 1); calcipala on first hind tarsomere narrow, pointed (Fig. 2); pedisulcus on second hind tarsomere insignificant 3

2′ Ratio of length of basal section of radius to length of remainder of wing 1:2.9 – 1:3.9; basal cell absent; calcipala on first hind tarsomere broadly rounded (Fig. 3); pedisulcus deep 4

3 (2) Size smaller, wing 2.0–3.0 mm long; Sc setose ventrally; gonostylus with one minute terminal tooth (Fig. 4) ..... *Metacnephia saskatchewana* Shewell and Fredeen

3′ Size larger, wing 4.0 – 4.5 mm long; Sc bare ventrally; gonostylus with two terminal teeth ..... *Ectemnia taeniatifrons* (Enderlein)

4 (2′) Mesepimeral tuft (Fig. 5) pale; ventral plate conical and about as wide as base of gonostylus, markedly convex and with ventral surface clothed in long pale bristles ..... *Simulium duplex* Shewell and Fredeen

4′ Mesepimeral tuft dark; ventral plate broadly rectangular, more than two times wider than base of gonostylus, ventral surface bare, shining, concave ..... *Simulium euryadminiculum* Davies

5 (1′) Gonostylus with three or more teeth and almost square; scutum with two silvery pollinose vittae ..... *Simulium vittatum* Zetterstedt

5′ Gonostylus with one or no teeth and longer than wide in most species; scutum generally without distinct vittae 6

6 (5′) Scutellum yellow; lateral and anterior margins of scutum yellow; gonostylus flat, quadrangular, shorter than gonocoxite; ventral plate broad and membranous 7

6′ Scutellum and margins of scutum not yellow; gonostylus more or less cylindrical, longer than wide and as long as, or longer than gonocoxite; ventral plate variously shaped 8

7 (6) Integument predominantly black; central area of scutum black with two anterior, lance-shaped, silvery-pollinose spots or short vittae ..... *Simulium bivittatum* Malloch

7′ Integument predominantly greyish-yellow; scutum greenish-grey with two anterior, rectangular, indistinctly pollinose spots ..... *Simulium griseum* Coquillett

8 (6′) Ventral plate relatively broad with basal arms extended laterally, slightly beyond margins of plate 9

8′ Ventral plate spike or tooth-shaped with basal arms extended laterally well beyond margins of plate 11

9 (8) Scutum velvety black suffused with ashen pollinosity especially on anterior half (best seen with horizontal illumination); scutum without prominent shining, white bars or spots, but with three indistinct dark vittae; scutum densely covered with golden hairs; gonostylus without prominent medio-basal lobe ..... *Simulium meridionale* Riley

9′ Scutum velvety black with prominent shining white bar near each anterior corner; scutum sparsely clothed with golden or brown hairs; gonostylus with prominent medio-basal lobe 10

10 (9′) Medio-basal lobe on gonostylus covered with fine hairs only ..... *Simulium rugglesi* Nicholson and Mickel

10′ Medio-basal lobe on gonostylus covered with short stout spines ..... *Simulium tuberosum* (Lundstroem)

11 (8′) Ventral plate markedly compressed laterally, "Y"-shaped when seen in ventral view 12

11′ Ventral plate tooth-shaped in ventral view 13

12 (11) Ventral plate not prominently hairy; gonostylus about three times longer than wide; scutum with single pair of silvery-pollinose spots extended from anterior corners toward center of scutum ..... *Simulium arcticum* Malloch

12′ Ventral plate prominently hairy; gonostylus about two times longer than wide;

scutum with two pairs silvery pollinose spots, each occupying more than one third of disc ..... *Simulium decorum* Walker

13 (11′) Posterior quarter of scutum with sparse, fine hairs; arms of ventral plate each with postero-medial projection ..... *Simulium luggeri* Nicholson and Mickel

13′ Posterior quarter of scutum with strong, erect hairs; arms of ventral plate without prominent lateral projections 14

14 (13′) Ventral plate relatively broad with approximate outline of molar tooth; notched margins of keel of ventral plate flared outward in "V"-shape ..... *Simulium venustum* Say

14′ Ventral plate laterally compressed as narrow keel; notched margins of keel turned inward and parallel with one another ..... *Simulium verecundum* Stone and Jamnback

ADULTS, Females

1 Entire vein R of wing clothed with hairs (setae) dorsally (Fig. 1) 2

1′ Basal section of vein R bare 5

2 (1) Basal cell present (Fig. 1); ratio of length of basal section of radius (Rb, Fig. 1) to length of remainder of wing 1:2.5–1:3.0; calcipala on first hind tarsomere narrow and pointed; pedisulcus on second hind tarsomere shallow and indistinct (Fig. 2) 3

2′ Basal cell absent; ratio of length of basal section of radius to length of remainder of wing 1:2.9–1:3.9; calcipala on first hind tarsomere prominent except in *S. vittatum* and rounded; pedisulcus on second hind tarsomere deep (Fig. 3) 4

3 (2) Frons with nearly parallel sides, narrowest near middle (Fig. 6); size larger (wing 4.0–4.5 mm long); R dorsally with setae, but lacking black spinules ..... *Ectemnia taeniatifrons* (Enderlein)

3′ Frons wedge-shaped, narrowest anterio-ventrally (Fig. 7); size smaller (wing 2.0–3.0 mm long); R dorsally with setae plus black spinules ..... *Metacnephia saskatchewana* Shewell and Fredeen

4 (2′) Medial and two lateral vittae on scutum narrow, black ..... *Simulium duplex* Shewell and Fredeen

4′ Medial and two lateral vittae on scutum narrow, white ..... *Simulium euryadminiculum* Davies

5 (1′) Claw with prominent, thumb-like basal projection (Fig. 8) 6

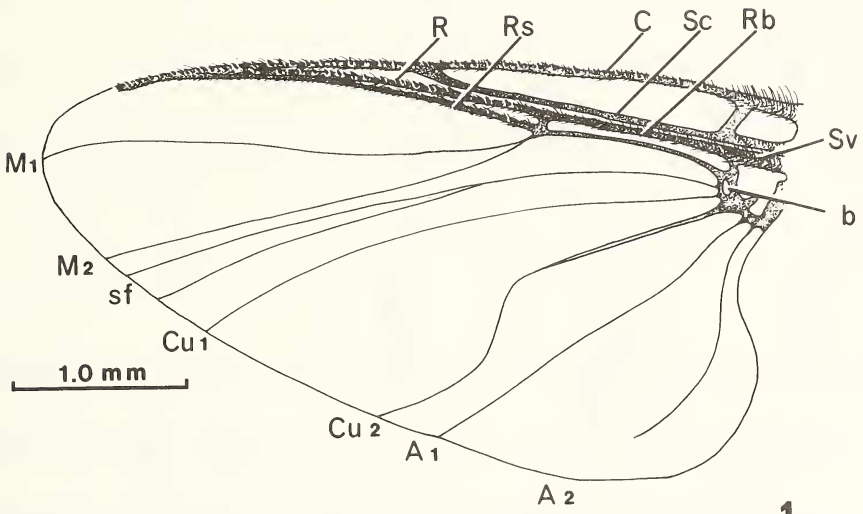
5′ Claw simple or with minute sub-basal tooth (Figs. 9, 10, 11) 7

6 (5) Foreleg entirely dark; width of frons at narrowest point about one-quarter as long as frons; frons and terminal abdominal terga grey-pollinose; scutum densely grey, pollinose with three narrow, brown vittae ..... *Simulium meridionale* Riley

6′ Fore coxa and about three-quarters of tibia pale yellow; width of frons at narrowest point about one-half as long as frons; frons and terminal abdominal terga shining dark brown; scutum thinly grey pollinose, subshining and without three narrow brown vittae ..... *Simulium rugglesi* Nicholson and Mickel

7 (5′) Small yellowish flies with postnotum contrastingly dark and with dark dorsal spots on abdomen and ends of some leg articles 8

Fig. 1. Wing of *Ectemnia taeniatifrons* (Enderlein), showing: basal cell (b); stem vein (Sv); basal section of radius (Rb); subcosta (Sc); costa (C); radial sector (Rs); radius (R); media (M_1, M_2); submedial false vein (sf); cubitus, anterior branches (Cu_1, Cu_2), and Anals (An_1, An_2). Fig. 2. Tarsomeres of *E. taeniatifrons*, showing: pointed calcipala (c), on first tarsomere; and shallow pedisulcus (p), on second tarsomere. Fig. 3. Tarsomeres of *Simulium duplex* Shewell & Fredeen, showing: rounded calcipala (c), and deep pedisulcus (p). Fig. 4. Terminalia of male *Metacnephia saskatchewana* Shewell & Fredeen: parameral spines (p); ventral plate (v); ventral plate arm (a); gonocoxite (gc); gonostylus (gs); and terminal spine (s).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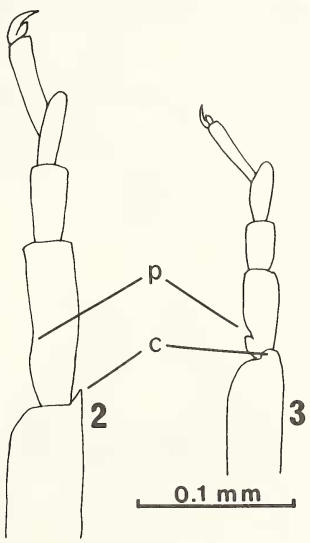
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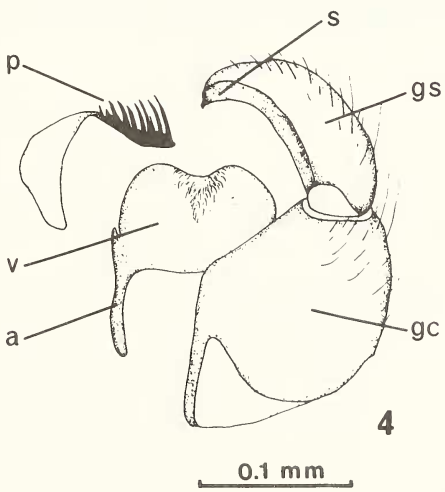
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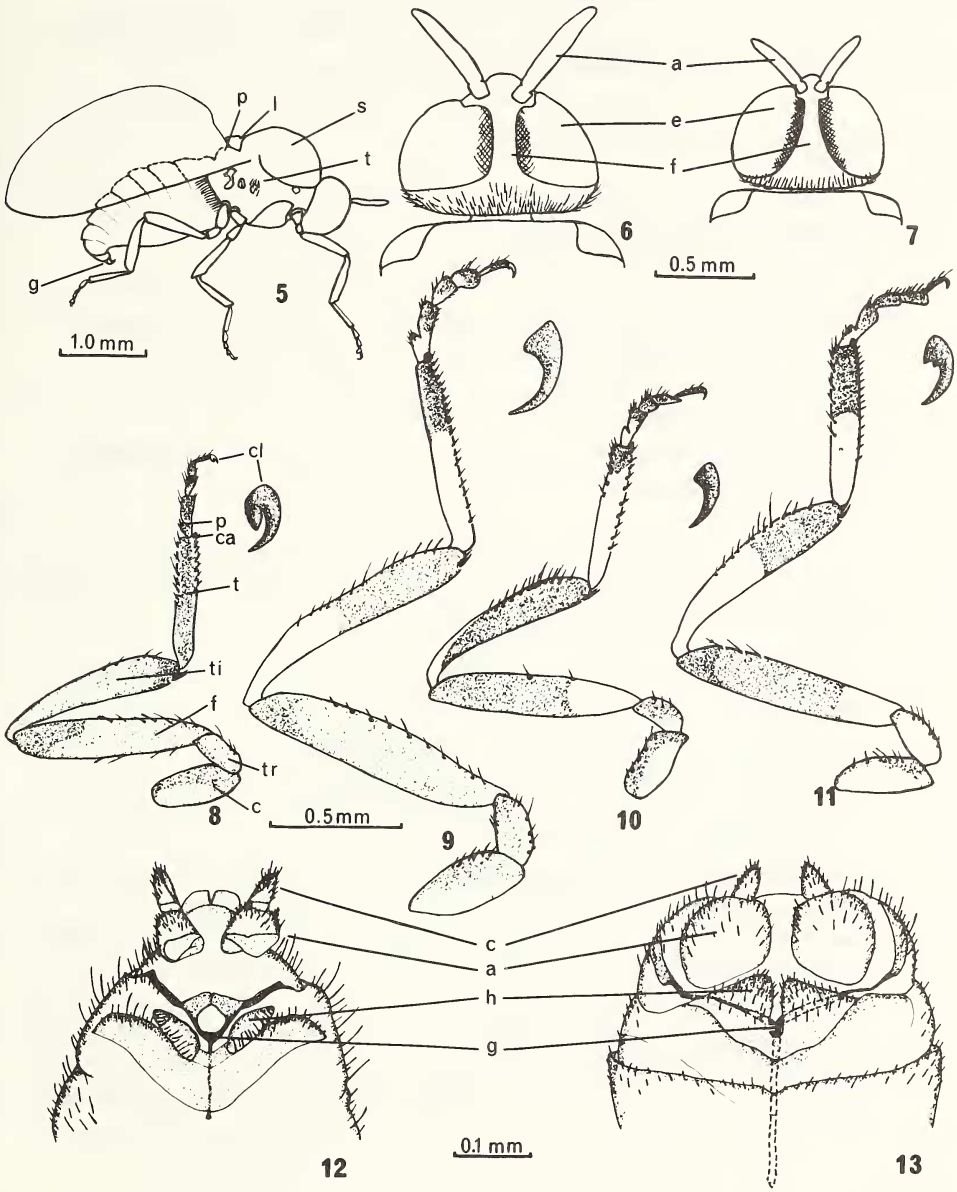
Fig. 5. Male of *Simulium duplex* Shewell & Fredeen, left lateral aspect: mesepimeral tuft (t); scutum (s); scutellum (1); postnotum (p); gonostylus of terminalia (d).

Figs. 6 and 7. Head, female, dorsal aspect, showing: antenna (a); eye (e); and frons (f), of : 6, *Ectemnia taeniatifrons*; and 7, *Metacnephia saskatchewana* Shewell & Fredeen.

Figs. 8–11. Third leg of female *Simulium*: claw (cl); pedisulcus on second tarsomere (p); calcipala (ca); first tarsomere (t); tibia (ti); femur (f); trochanter (tr); and coxa (c), of : 8. *S. meridional* Riley; 9, *S. vittatum* Zetterstedt; 10, *S. luggeri* Nicholson & Mickel; and 11, *S. arcticum* Malloch.

Figs. 12 and 13. Terminalia of female *Simulium*, ventral view: cercus (c); anal lobe (a); hypogynial valve (h); and genital fork (g), of : 12, *S. luggeri*; and 13, *S. arcticum*.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7′ Greyish or brownish flies without contrastingly dark postnotum 9
8 (7) Scutum with seven alternating stripes of yellowish-grey and brownish orange ..... *Simulium bivittatum* Malloch
8′ Scutum yellowish-grey without distinct striped pattern ..... *Simulium griseum* Coquillett
9 (7′) Scutum distinctly striped; color patterns of third leg segments as in Fig. 9 ..... *Simulium vittatum* Zetterstedt
9′ Scutum not distinctly striped (indistinct vittae may be seen at certain angles of view) 10
10 (9′) Subcosta without setae (rarely one or two) on ventral surface; terminalia with hypogynial valves widely separated and not obscuring genital fork (Fig. 12); color pattern of third leg as in Fig. 10 ..... *Simulium luggeri* Nicholson and Mickel
10′ Subcosta with row of setae on ventral surface (sockets visible if setae lost); terminalia with hypogynial valves almost meeting medially, thus obscuring genital fork (Fig. 13) 11
11 (10′) Hind tibia with distal half dark and proximal half pale (Fig. 11); claw with minute subbasal tooth ..... *Simulium arcticum* Malloch
11′ Hind tibia dark except slanted "knee patch" (Fig. 10); claw without minute subbasal tooth 12
12 (11′) Frons and terminal abdominal terga thinly grey pollinose; anal lobe twice as long as cercus, almost square ..... *Simulium decorum* Walker
12′ Frons and terminal abdominal terga shiny black or brown; anal lobe scarcely longer than cercus, wider than long 13
13 (12′) Fore coxa, trochanter and entire femora as dark as first tarsomere; setae on stem vein and base of costa dark; entire antenna dark; a small dark species (wing length often under 2.0 mm) ..... *Simulium tuberosum* (Lundstroem)
13′ Fore coxa, trochanter and proximal portion of femur paler than first tarsomere; setae on stem vein and base of costa pale; pedicel of antenna relatively pale; size various; abdomen pale ventrally 14
14 (13′) Medial margins of hypogynial valves straight and slightly divergent distally; anterior margin of anal lobe not noticeably more sclerotized than rest of lobe; width and length of dorsal sclerites on third and fifth abdominal segments approximately equal ..... *Simulium venustum* Say
14′ Medial margins of hypogynial valves concave with oval space between them; anterior margin of anal lobe noticeably more sclerotized than rest of lobe; dorsal sclerites on third and fifth abdominal segments approximately two times wider than long ..... *Simulium verecundum* Stone and Jamnback

PUPAE

1 Cocoon loosely woven throughout 2
1′ Cocoon tightly woven, at least in posterior portion 3
2 (1) Cocoon sock-shaped, attached or not to short stalk; ten filaments in respiratory organ (Fig. 14) ..... *Ectemnia taeniatifrons* (Enderlein)
2′ Cocoon boot-shaped (elavated anterior collar), not attached to stalk; 17 to 19

filaments in respiratory tuft, irregularly branched (Fig. 15) ..... *Metacnephia saskatchewana* Shewell and Fredeen

3 (1′) Pupal respiratory organ with four or fewer filaments 4

3′ Pupal respiratory organ with more than four filaments 5

4 (3) Pupal respiratory organ of two (rarely three or four) stout filaments (Fig. 16) ..... *Simulium duplex* Shewell and Fredeen

4′ Pupal respiratory organ of four slender filaments (Fig. 17) ..... *Simulium euryadminiculum* Davies

5 (3′) Pupal respiratory organ of six filaments 6

5′ Pupal respiratory organ of more than six filaments 8

6 (5) Pupa and cocoon relatively small (about 3.0 mm long) and dark; respiratory filaments less than half as long as cocoon (Fig. 18) ..... *Simulium tuberosum* (Lundstroem)

6′ Pupa and cocoon 4.0 mm or longer, pale; respiratory filaments more than half as long as cocoon 7

7 (6′) Respiratory filaments relatively fine, spread about 90 degrees at base (Fig. 19) ..... *Simulium venustum* Say

7′ Respiratory filaments relatively coarse, spread up to 180 degrees at base (Fig. 20) ..... *Simulium verecundum* Stone and Jamnback

8 (5′) Respiratory organ with eight filaments 9

8′ Respiratory organ with more than eight filaments 11

9 (8) Respiratory filaments grouped as pairs on four long petioles (Fig. 21) ..... *Simulium rugglesi* Nicholson and Mickel

9′ Respiratory filaments not paired 10

10 (9′) Cocoon more than four mm long, loosely woven (Fig. 22) . Simulium decorum Walker

10′ Cocoon about three mm long, tightly woven (Fig. 23) ..... *Simulium bivittatum* Malloch and *Simulium griseum* Coquillett[1]

11 (8′) Pupal respiratory organ with 12 filaments 12

11′ Pupal respiratory organ with more thar 12 filaments 13

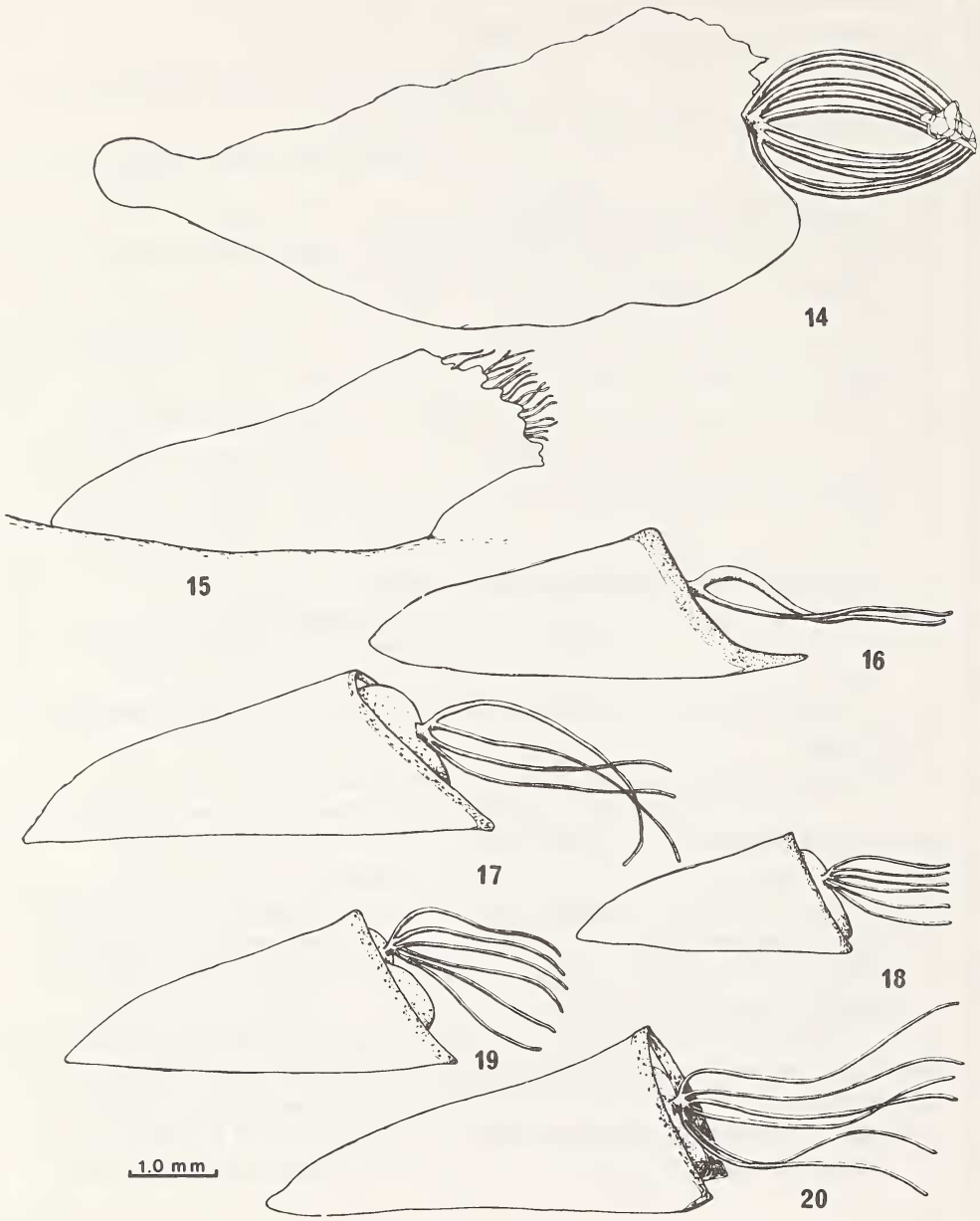
12 (11) Filaments in respiratory organ paired; cocoon boot-shaped (with an elevated anterior collar) (Fig. 24) ..... *Simulium arcticum* Malloch

12′ Filaments in respiratory organ in groups of three; cocoon generally slipper-shaped (without anterior collar) (Fig. 25) ..... *Simulium luggeri* Nicholson and Mickel

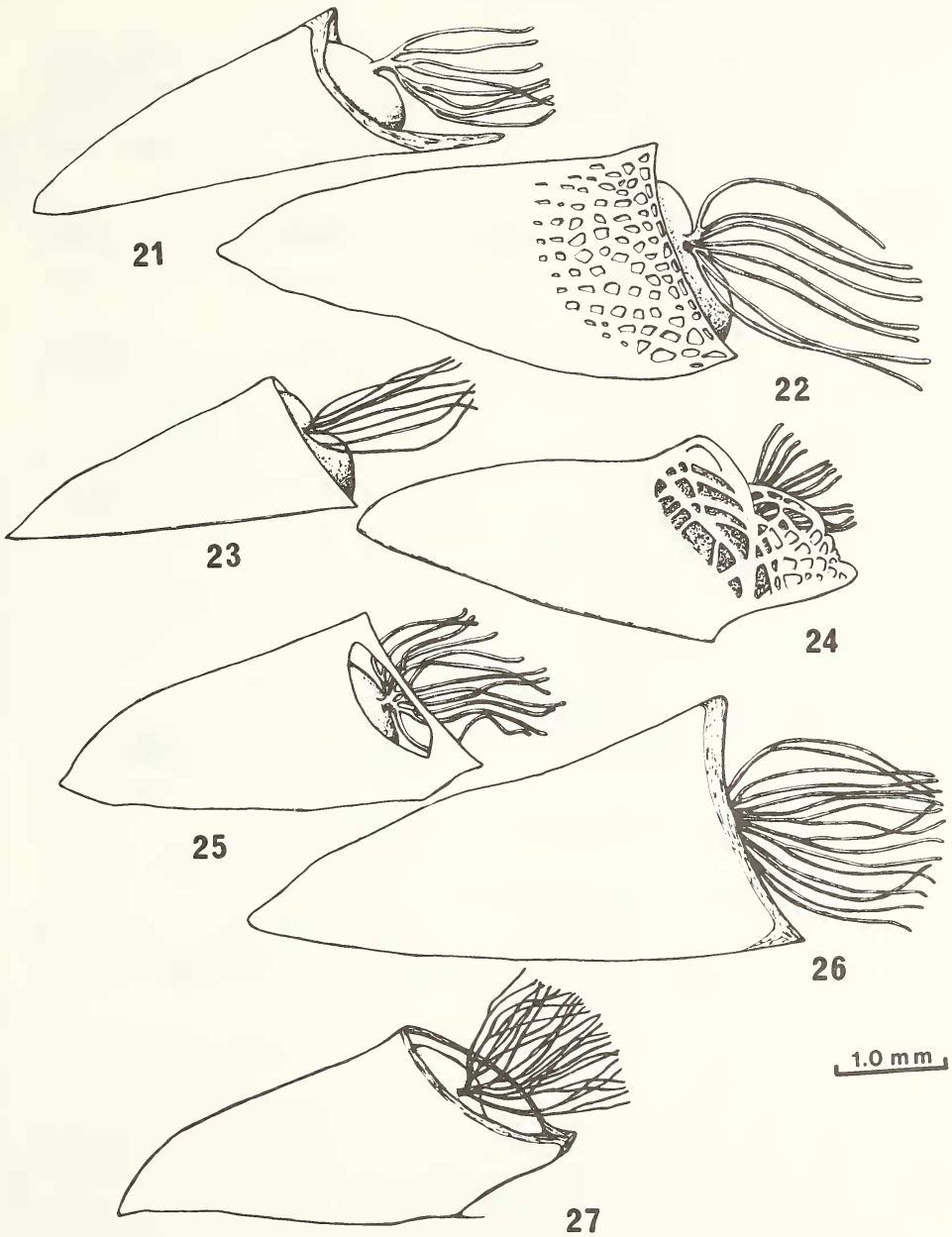
13 (11′) Pupal respiratory organ with 16 filaments, in pairs; cocoon slipper-shaped (Fig. 26) ..... *Simulium vittatum* Zetterstedt

13′ Pupal respiratory organ with 22 to 26 irregularly branched filaments; many cocoons boot-shaped (Fig. 27) ..... *Simulium meridionale* Riley

[1]*Simulium bivittatum* Malloch and *S. griseum* Coquillett may be reliably separated as adults.



Figs. 14–20. Cocoon, and one set of respiratory filaments of pupa, of: 14, *Ectemnia taeniatifrons* (Enderlein); 15, *Metacnephia saskatchewana* Shewell & Fredeen; 16, *Simulium duplex* Shewell & Fredeen; 17, *S. euryadminiculum* Davies; 18, *S. Tuberosum* (Lundstroem); 19, *S. venustum* Say; 20, *S. verecundum* Stone & Jamnback.



Figs. 21–27. Cocoon and one set of respiratory filaments of pupa, of: 21, *Simulium rugglesi* Nicholson & Mickel; 22, *S. decorum* Walker; 23, *S. griseum* Coquillett, and *S. bivittatum* Malloch; 24, *S. arcticum* Malloch; 25, *S. luggeri* Nicholson & Mickel; 26, *S. vittatum* Zetterstedt; and 27, *S. meridionale* Riley.

LARVAE

1		Three unbranched anal gills (Fig. 28) 2
1′		Three compound anal gills 5
2	(1)	Lateral margins of abdominal segments 5 to 8 extended ventrally to about twice depth of segments 1 to 4 (Fig. 28); prominent pair of ventral tubercles (Fig. 28); ventral view of head capsule (Fig. 29) ..... *Ectemnia taeniatifrons* (Enderlein)
2′		Lateral margins of abdominal segments 5 to 8 not extended ventrally; anal sclerites darkly sclerotized (Fig. 30); ventral tubercles insignificant 3
3	(2′)	Arms of anal sclerite as in Fig. 31; postgenal cleft extended to base of hypostomium (Fig. 32) ..... *Metacnephia saskatchewana* Shewell and Fredeen
3′		Arms of anal sclerite as in Fig. 33; postgenal cleft extended less than half distance to base of hypostomium (Fig. 34) 4
4	(3′)	Suboesophageal ganglion dark (Fig. 34); larva relatively large (> 7 mm long when mature) and with prominent dark, greenish transverse bands ..... *Simulium vittatum* Zetterstedt
4′		Suboesophageal ganglion almost invisible (Fig. 35); larva relatively small (< 5 mm long when mature) and without prominent dark transverse bands ..... *Simulium bivittatum* Malloch and *Simulium griseum* Coquillett[2]
5	(2′)	Eighth abdominal segment with two prominent ventral tubercles; abdominal integument sparsely clothed in fine short bristles 6
5′		Eighth abdominal segment without prominent ventral tubercles; abdominal integument essentially bare 10
6	(5)	Postgenal cleft extended to base of hypostomium (Figs. 36, 37) 7
6′		Postgenal cleft not extended to base of hypostomium (Fig. 38) 8
7	(6)	Prominent row of bristly tubercles in transverse reddish band encircling each of segments 1 to 5, smaller tubercles on remaining segments; suboesophageal gland colorless ..... *Simulium meridionale* Riley
7′		Abdomen without bristly tubercles; suboesophageal gland dark ..... *Simulium rugglesi* Nicholson and Mickel
8	(6′)	Ventral tubercles broadly rounded; postgenal cleft broadly rounded, extended about three quarters of distance to base of hypostomium (Fig. 38) ..... *Simulium luggeri* Nicholson and Mickel
8′		Ventral tubercles distinctly conical; postgenal cleft extended no more than half distance to base of hypostomium 9
9	(8′)	Postgenal cleft extended about one-third of distance to base of hypostomium, bilobed (Fig. 39) ..... *Simulium euryadminiculum* Davies
9′		Postgenal cleft extended about one-half of distance to base of hypostomium, not bilobed (Fig. 40) ..... *Simulium duplex* Shewell and Fredeen
10	(5′)	Medial spots on dorsal surface of head capsule dark 11
10′		Medial spots on dorsal surface of head capsule pale 12
11	(10)	Suboesophageal ganglion dark; postgenal cleft extended about half way to base of hypostomium (Fig. 41) ..... *Simulium tuberosum* (Lundstroem)
11′		Suboesophageal ganglion almost colorless; postgenal cleft extended about three-quarters of distance to base of hypostomium (Fig. 42) .....

[2]*S. bivittatum* and *S. griseum* may be reliably separated as adults only.

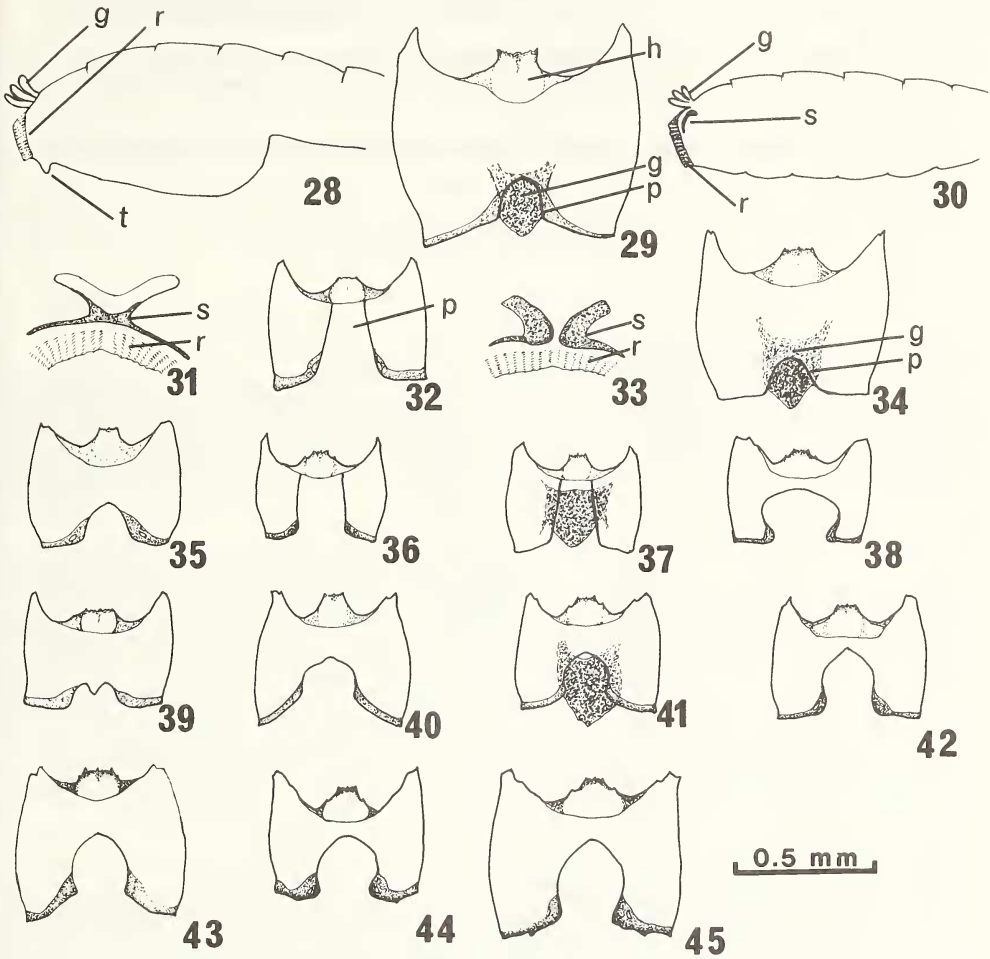


Fig. 28. Lateral view of posterior portion of abdomen of *Ectemnia taeniatifrons* (Enderlein) larva: anal gills; g); posterior ring of hooklets (r); ventral tubercle (t). Not drawn to scale. Fig. 29. Ventral view of head capsule of *E. taeniatifrons* larva: hypostomium (h); suboesophageal ganglion (g); margin of postgenal cleft (p). Fig. 30. Lateral view of *Metacnephia saskatchewana* Shewell & Fredeen larva: anal gills (g); portion of posterior ring of hooklets (r). Not drawn to scale. Fig. 31. Dorsal view of anal sclerites of *M. saskatchewana* larva: anal sclerite (s); portion of posterior ring of hooklets (r). Not drawn to scale. Fig. 32. Ventral view of head capsule of *M. saskatchewana* larva: postgenal cleft (p). Fig. 33. Dorsal view of anal sclerites of *Simulium vittatum* Zetterstedt larva: anal sclerite (s); portion of posterior ring of hooklets (r). Not drawn to scale. Figs. 34–45. Ventral view of head capsule of *Simulium* larvae: suboesophageal ganglion (g); margin of postgenal cleft (p), of: 34, *S. vittatum* Zetterstedt; 35, *S. griseum* Coquillett and *S. bivittatum* Malloch; 36, *S. meridionale* Riley; 37, *S. rugglesi* Nicholson & Mickel; 38, *S. luggeri* Nicholson & Mickel; 39, *S. euryadminiculum* Davies; 40, *S. duplex* Shewell & Fredeen; 41, *S. tuberosum* (Lundstroem); 42, *S. articum* Malloch; 43, *S. decorum* Walker; 44, *S. venustum* Say; 45, *S. verecundum* Stone & Jamnback. (Scale applies to head capsules, only).

. . . . . *Simulium arcticum* Malloch

12 (10′) Mature larvae large (many 7 mm long); antenna extended as far as distal end of stalk of cephalic fan; postgenal cleft slightly longer than wide (Fig. 43) . . . . . *Simulium decorum* Walker

12′ Mature larvae smaller (many 6 to 6.5 mm long); tip of antenna extended beyond distal end of stalk of cephalic fan; postgenal cleft about as long as wide (Figs. 44, 45) . . . . . *Simulium venustum* Say and *Simulium verecundum* Stone and Jamnback[3]

NOTES ABOUT SPECIES

1. *Ectemnia taeniatifrons* (Enderlein) (Figs. 1, 2, 6, 14, 28, 29)

Thirty years ago larvae and pupae of this species were widely distributed throughout the north, south, and main branches of the Saskatchewan River in Saskatchewan; none were found in tributaries. In recent years fewer specimens have been collected and those mainly near the confluence of the north and south branches near Prince Albert, the Red Deer River near Estuary and the South Saskatchewan River near Pike Lake.

Ectemnia taeniatifrons is univoltine. Eggs laid in April and May hatch in late summer. At fall freeze-up, some larvae are almost half grown. Larvae are notable in that many are found attached to the tips of slender stalks up to 15 mm long, built from threads of salivary secretions and debris and attached with broad bases to substrates. If undisturbed, a larva attaches its cocoon on or near the tip of its stalk. Larvae continue growth under the ice and adults commence emerging three to five weeks after ice break-up. Adults commonly feed on sap seeping from the bruised bark of birch trees. Mating occurs in flight in thinly dispersed swarms in clearings and thereafter, the females seek blood from humans and other animals. Because of its rarity the species was not considered to be economically important.

2. *Metacnephia saskatchewana* Shewell and Fredeen (Figs. 4, 7, 15, 30–32)

Larvae and pupae occur regularly on water weeds collected in the spring from the Shell and Battle Rivers in Saskatchewan and occasionally from the North Saskatchewan River as far as about 50 km downstream from the outlets of those small tributaries. I believe that the species is not native to the Saskatchewan River, but that larvae appear there only after accidentally drifting in from tributaries. The cocoons possess the same shape as those of *S. arcticum*, but are loosely constructed and the pupa possesses 17 to 19 respiratory filaments instead of 12.

Only one generation per year is known. Adults emerge four to eight weeks after ice break-up suggesting that the species overwinters as larvae under the ice of permanently flowing rivers. Feeding habits of adults are not known.

Type specimens for this species were collected from the Shell River (Shewell and Fredeen, 1958) and since then it has been shown to be widely distributed in western Canada.

[3]*S. venustum* and *S. verecundum* may be reliably separated in the pupal and adult stages only.

3. *Simulium (Eusimulium) euryadminiculum* Davies (Figs. 17 and 39)

This species breeds abundantly in the Battle and Shell Rivers. Larvae occasionally drift into the North Saskatchewan River and have been collected as far as about 60 km downstream from those tributaries. There, adults are sometimes produced judging by empty pupal cases, but there is no evidence of permanent establishment in the Saskatchewan River. *S. euryadminiculum* is univoltine with adults emerging in May about three to five weeks after ice break-up. Blood-fed females have been taken from a dead common loon (Davies *et al.*, 1962) and have driven chickens indoors in Saskatchewan, without causing losses. The most severe attack on chickens occurred May 16 to 18, 1981, near Prongua, Saskatchewan.

4. *Simulium (Eusimulium) duplex* Shewell and Fredeen (Figs. 3, 5, 16 and 40).

Larvae and pupae of this species occur regularly in the Battle and Shell Rivers, the source of type specimens (Shewell and Fredeen, 1958) and in small numbers in the Saskatchewan River below their outlets. They were collected once from the Red Deer River immediately above its confluence with the South Saskatchewan River in southwestern Saskatchewan. *S. duplex* is univoltine, with pupation usually occurring in late May. Feeding habits of adults are not known.

5. *Simulium (Byssodon) meridionale* Riley (Figs. 8, 27 and 36).

S. meridionale is widely distributed throughout many rivers and streams in Saskatchewan. Recently, larvae have become relatively abundant in the North Saskatchewan River, especially in the vicinities of the Wingard and Cecil ferries. They also occur in the Red Deer and South Saskatchewan Rivers in southwest Saskatchewan and occasionally downstream from Tobin Lake on the main Saskatchewan.

Eggs overwinter in river bed sand and commence hatching within a month after ice break-up in the spring. The species is multivoltine. Larval populations often peak in May and June in the South Saskatchewan and in July in the north branch. It is sometimes abundant enough to be a pest of humans and other animals. In some localities such as Melville, Saskatchewan, it has been a pest of poultry and implicated indirectly in fatal proven *Leucocytozoon* infections in flocks of domestic poultry. Those outbreaks originated in small local streams not connected with the Saskatchewan River. Possibly sibling species of *S. meridionale* possessing different host preferences are involved. Surprisingly, summer-long emergences of relatively large numbers of *S. meridionale* in recent years from the North Saskatchewan River did not result in poultry losses until early July 1981, when six farmers in a 100,000 ha area near Nipawin, Saskatchewan reported losses. Veterinarians considered those fatalities due to exsanguination rather than disease. *S. meridionale* females were abundant inside chicken house windows. Deaths occurred too rapidly to allow collection of blood smears. Until more information is available poultry producers should avoid establishing new flocks out-of-doors near the North Saskatchewan River. Swarms of *S. meridionale* have been bothersome as far as 15 km from that river in recent years. Poultry producers already established should report immediately any massive illnesses in their flocks to the Western College of Veterinary Medicine at Saskatoon. Blood is required from living birds for diagnosis.

6. *Simulium (Byssodon) rugglesi* Nicholson and Mickel (Figs. 21 and 37)

Eggs, larvae and pupae of this species occur regularly and sometimes abundantly in small clear rivers such as, the Battle, Shell, and Torch, and in small numbers in the North Saskatchewan River below the outlets of those tributaries.

Eggs overwinter in river bed sand and commence hatching about one month after ice break-up in spring. Larvae attain maximum abundance about mid-June, but may be found until September, suggesting more than one generation per summer.

Shewell (1955) identified *S. rugglesi* as the species believed responsible for transmitting fatal *Leucocytozoon* infections to ducklings and goslings in eastern Canada. However, there have not been any reports of this black fly attacking poultry in Saskatchewan.

7. *Simulium (Psilopelmia) bivittatum* Malloch and 8. *S. (Psilopelmia) griseum* Coquillett (Figs. 23 and 35)

I was not able to reliably separate immature stages of these two species. Adults reared from pupae collected throughout the ice-free season in 1976 showed that the two species occurred together that year in both the South Saskatchewan and Red Deer Rivers in southwest Saskatchewan. In earlier years larvae and pupae of both species were found every summer in the South Saskatchewan River. They were abundant in upper reaches, but rare in lower reaches of that river and absent from the North Saskatchewan River. Populations in the lower South Saskatchewan apparently were renewed annually by downstream drift of eggs and larvae from breeding sites much further upstream because specimens have not been collected since completion of a hydroelectric dam near Macrorie in 1968.

At Estuary, newly-hatched larvae appeared in May, a few weeks after ice break-up. Development was rapid and by late May pupation commenced. Both species were multivoltine and attained maximum abundance in July and August. Occasional severe outbreaks until about 1965 used to force people indoors at Saskatoon and Medicine Hat (Alberta). Adults of these species also attacked horses, cattle, sheep and hogs, but apparently not poultry.

9. *Simulium (Psilozia) vittatum* Zetterstedt (Figs. 9, 26, 33, and 34).

Although *S. vittatum* is the most widely distributed black fly species in Saskatchewan it apparently did not become established in the Saskatchewan River until the 1960's, coincidental with appearance of several species of water weeds. Now immature stages occur throughout this river system and are particularly abundant in beds of weeds that provide attachment sites for larvae and pupae, and substrates suitable for egg masses on emergent leaves.

S. vittatum overwinters as eggs in the river bed, and occasionally as larvae. It is univoltine and attains greatest abundance in late July and early August. As a pest it is not considered too bothersome, even when adults are abundant. These are relatively unobstrusive in attacks, quietly entering the ears of animals where they feed undisturbed.

10. *Simulium (Gnus) arcticum* Malloch (Figs. 11, 13, 24, and 42)

S. arcticum was considered to be the only black fly species capable of killing livestock in Saskatchewan until recently when *S. luggeri* became the dominant species in the Saskatchewan River. Larvae and pupae used to occur throughout the entire Saskatchewan River in Saskatchewan, but were particularly abundant in rocky rapids in the final 150 km or so of each of the north and south branches and in the entire main river below their confluence. The most destructive outbreaks occurred from 1944 to 1947, inclusive, when more than 1,100 farm

animals, mainly cattle, were killed, including many expensive herd sires. Up to 3 million ha of farm lands in Saskatchewan were affected at irregular intervals by these outbreaks until advent of chemical larviciding in 1948 (Fredeen, 1958). Deaths were caused by direct toxemia. Native born mature mammals were relatively immune to the toxins, but outbreaks still caused indirect losses by interrupting grazing and breeding. Most outbreaks occurred in late May or early June, rarely in August.

Since the early 1960's numbers of larvae in these rivers gradually declined until this species no longer threatens livestock. The last outbreak in which fatalities occurred was in 1972 near Wingard. This decline seems not to have been caused by larviciding, as that affected only 150 km or shorter sections of these rivers, reinfested annually from untreated sections upstream. Rather, the decline coincided with a combination of several ecological changes including increases in amounts of dissolved plant nutrients, shallowing and clearing of water due to summertime impoundment behind new hydroelectric dams, and development of massive beds of aquatic plants. Reduced numbers of larvae of *S. arcticum* continue to inhabit rapids, however, and the species might return in bothersome numbers if eutrophication declines. *S. arcticum* overwinters as eggs in submerged river sand. First-instar larvae begin to appear 10 to 14 days after ice break-up in the spring and pupation commences four or more weeks later. A second, smaller generation often occurs in July or August.

Downstream drift of larvae undoubtedly played an important part in development of outbreaks. When river levels declined as they usually did in May and early June, larvae released and drifted downriver to more suitable sites in rocky rapids. It was from such accumulation points that many destructive outbreaks originated. Accumulation of unfed females awaiting weather conditions suitable for flight also was a factor. There was evidence, however, that some females could lay the first batch of eggs autogenously, that is, from nutrients stored during larval life (Fredeen, 1963).

Mammals within about 30 km of rapids were perhaps in greatest danger of attack. In 1947, mammals were killed near Simpson, Saskatchewan, some 200 km south of the nearest point of origin of black fly populations.

Three morphologically different forms of *S. arcticum* have been collected in Saskatchewan. The pest species from the Saskatchewan River was identified as *S. arcticum* by Stone (1959) after comparing it with Malloch's types. A second relatively small, pale variety is widespread in northern Saskatchewan and a third large, dark variety is in the Cypress Hills in southwest Saskatchewan.

11. *Simulium (Phosterodoros) luggeri* Nicholson and Mickel (Figs. 10, 12, 25, and 38).

S. luggeri is the most northerly distributed species of *Phosterodoros*, and is the only one known to occur in western Canada. Until the late 1960's breeding of *S. luggeri* Nicholson and Mickel in Saskatchewan was restricted to medium-sized clear rivers such as the Battle, Shell and Torch Rivers where there was vegetation for attachment by larvae. From these rivers larvae drifted in small numbers out into the North Saskatchewan River. However, they failed to colonize either branch of the Saskatchewan until perhaps 1968 when larvae were detected for the first time in the south branch near Fenton. By August, 1971, it was breeding so abundantly in that river that emerging swarms of adults stampeded cattle in a pasture near St. Louis. Also, for the first time in 1971 there was a distinct increase in numbers of larvae found attached to artificial substrates anchored in the north branch near Prince Albert, indicating that a breeding population had become established there. In 1976, larvae exceeded those of *S.*

arcticum in abundance and for the first time outbreaks of economic proportions originated repeatedly from that river. Since then, outbreaks have continued to severely affect people and livestock in some 18,000 km^2 of farmlands and recreational areas in east central Saskatchewan.

Even though *S. luggeri* does not poison animals as severely as does *S. arcticum*, the habit of swarming densely around heads of cattle causes stampeding. Grazing and breeding are repeatedly interrupted throughout the summer and fences are broken down. Young animals suffer broken bones and increased incidence of stress-related diseases such as pneumonia and diarrhoea. Summer-long outbreaks reached a peak in 1978, causing losses including unrealized weight gains that were estimated to have exceeded $1,400,000.00 Fredeen (in preparation). Relatively intensive larviciding prevented re-occurrences of these outbreaks in 1979.

S. luggeri is capable of about five generations per summer in this region. Like *S. arcticum* it overwinters as eggs in submerged sand. Hatching commences about two weeks after ice break-up in the spring and adults emerge in late May or early June. Attacks on people and livestock continue during warm days until late in the fall. Egg masses are attached to emergent vegetation and also, single eggs, similar to those of *S. arcticum* may be dropped onto the water surface .

12. *Simulium (sensu stricto) decorum* Walker (Figs. 22, and 43).

This species is distributed sparsely throughout the province. Larvae occur most frequently in the outfalls from small stream impoundments. Single larvae sometimes collected from the North Saskatchewan River presumably originated in small streams. Not enough is known about *S. decorum* to predict whether it could commence breeding in fast flowing sections of the Saskatchewan River. It overwinters as eggs in wet river sand and apparently is capable of several generations per summer. The females attack a wide vareity of animals. In northern Saskatchewan adults are sometimes abundant enough to create severe local problems for humans and other animals.

13. *Simulium (sensu stricto) tuberosum* (Lundstroem) (Figs. 18 and 41).

Landau (1962) showed that *S. tuberosum* (Lundstroem) in southern Ontario consists of a complex of at least four cytogenetically distinct species. Several morphological forms occur in Saskatchewan indicating a complex here, also.

Larvae occur sparsely but regularly in the North Saskatchewan River, especially downstream from tributaries that are normal habitats. Larvae were reliably reported from South Saskatchewan River for the first time in 1979 and again in 1980, when a few were collected from three sites, 20, 40 and 120 km upstream from the confluence with the north branch. This widespread distribution and lack of stream tributaries which might have contributed larvae, suggests that the species is now breeding in that river.

S. tuberosum (Lundstroem) may be multivoltine and adults have been collected along with those of *S. venustum* Say from swarms attacking humans and other animals. However, nowhere in the southern half of the province has it been abundant enough to create problems by itself.

14. *Simulium (sensu stricto) venustum* Say (Figs. 19, and 44).

S. venustum Say is one of the most widely distributed black flies in Saskatchewan and breeds in a wide variety of relatively unpolluted streams and rivers. Occasionally faster flowing sections of small rivers such as the Assioniboine, Big and Beaver have produced brief outbreaks

that have created problems for humans and other animals. In the early 1970's *S. venustum* Say commenced breeding sparsely in the last 50 km or more of both branches of the Saskatchewan River. Although still uncommon there it should be watched because of the large productive capacity of the Saskatchewan River.

S. venustum Say overwinters as eggs and is multivoltine, attaining greatest abundance in June. Rothfels (1975) considers this to be a species complex.

15. *Simulium (sensu stricto) verecundum* Stone and Jamnback (Figs. 20, and 45).

Larvae and pupae of this species occasionally have been colleted from the last 50 km or so of each branch of the Saskatchewan River. Although it may become more abundant it probably will not become economically important because it is not known to attack for blood.

PRACTICAL CONSIDERATIONS

The black fly fauna of the Saskatchewan River in Saskatchewan has changed considerably during the past 15 years coinciding with changes in river conditions. Originally *S. arcticum* was the dominant species. Sporadic outbreaks that killed livestock belonging to the earliest settlers in 1885 were attributed to this species. As recently as 1972 an outbreak of *S. arcticum* originating from an untreated portion of the North Saskatchewan River killed 18 farm animals near Wingard. Since then, however, *S. luggeri* has gradually replaced *S. arcticum* as the dominant species and the conversion is believed due to changes in river conditions that allowed growth of large beds of aquatic plants on previously barren river beds. Losses estimated to have exceeded $1,400,000.00 resulted from summer-long outbreaks of *S. luggeri* in 1978 (Fredeen, in preparation).

Tendencies towards continuing changes in black fly populations were indicated by appearances of larvae of *S. tuberosum* (Lundstroem) and *S. venustum* Say in several sites in 1979 and 1980. Troublesome outbreaks of those two blood sucking species have been reported from several small prairie rivers. Thus their populations should be monitored annually along with those of blood sucking species in the relatively large Saskatchewan River.

At present, chemical larviciding offers the only means of preventing outbreaks (Fredeen, 1977). Continued research may eventually provide other methods. Residents in areas recently affected by outbreaks of *S. arcticum* Malloch and *S. luggeri* Nicholson and Mickel require assurance that protection will be provided when required. It is hoped that this key to species inhabiting the Saskatchewan River will prove useful for monitoring and research.

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